Wenham Pines
Main Street

Wenham, MA
July 19, 2016

Prepared by:

BAYSIDE ENGINEERING

600 Unicorn Park Drive
Woburn, MA 01801
781-932-3201
www.baysideengineering.com

Prepared for:

Wenham Pines, LLC

TRAFFIC IMPACT AND ACCESS STUDY

WENHAM PINES

MAIN STREET
WENHAM, MASSACHUSETTS

Prepared for:

Atlantic Tambone

July 19, 2016

Prepared by:

Bayside Engineering
600 Unicorn Park Drive
Woburn, MA 01801

TABLE OF CONTENTS

Section	Title	Page
1	**Executive Summary**	1
2	**Existing Traffic Conditions**	6
	Study Area	6
	Field Survey	6
	Geometrics	6
	Traffic Volumes	7
	Vehicle Speeds	10
	Motor Vehicle Crash Data	10
	Public Transportation	10
	Planned Roadway Improvements	11
3	**2023 No-Build and Build Future Conditions**	12
	2023 No-Build Traffic Volumes	12
	Future 2023 Build Conditions	15
4	**Capacity Analysis**	19
	Methodology	19
	Analysis Results	21
	Sight Distance	23
5	**Recommendations and Conclusion**	25
	Recommendations	25
	Conclusion	25
	Appendix	

TABLES

No.	Title	Page
1	Existing Weekday Traffic-Volume Summary	8
2	Observed Vehicle Speeds	10
3	Residential Development Trip Generation Summary	15
4	Proposed Trip Distribution	16
5	Traffic Volume Increases	18
6	Level-of-Service Criteria for Unsignalized Intersections	20
7	Level-of-Service Criteria for Signalized Intersections	21
8	Unsignalized Level-of-Service Analysis Summary	22
9	Sight Distance Summary	24

FIGURES

No.	Title	Page
1	Site Location Map	2
2	2016 Existing Weekday Peak Hour Traffic Volumes	9
3	2023 No-Build Weekday Peak Hour Traffic Volumes	14
4	2023 Build Weekday Peak Hour Traffic Volumes	17

SECTION 1: EXECUTIVE SUMMARY

Bayside Engineering has prepared this study to assess the traffic impact and to evaluate the access requirements of a proposed residential development located on Main Street in Wenham, Massachusetts. The proposed development, Wenham Pines, will be located on the site of the former Lakeview Golf Course and is proposed to consist of a phased, 25-unit residential condominium development, consisting of 11 new townhouse style buildings containing 23 market units, along with 2 newly renovated affordable units located within the existing house at 56 Main Street.

This report identifies existing traffic operating parameters on key roadways and intersections within the study area, evaluates the anticipated traffic volume increases as a result of the proposed project, analyzes the project's traffic-related impacts, determines the projects access/egress requirements and identifies appropriate mitigating measures designed to minimize the traffic-related impacts created by the project. The following provides a brief summary of the project and the study's findings.

PROJECT DESCRIPTION

The development is to be located on the east side of Main Street (Route 1A), across from Fiske Road. Currently, the site consists of the existing 9-hole Lakeview Golf Course and a single-family home (#56 Main Street). Access is currently provided by way of two full access driveways to Main Street.

Wenham Pines will be a phased, 25-unit residential condominium development, consisting of 11 new townhouse style buildings containing 23 market units, along with 2 newly renovated affordable units located within the existing house at 56 Main Street. The existing north site driveway is proposed to be closed[1]. A new driveway will be constructed opposite Fiske Road to serve the new condominium units. The existing south site driveway will be maintained and will continue to serve the single-family home that is

[1] Existing driveway is part of shared easement with the abutting property to the north. This easement will continue to serve that property.

located on the site. This home will be expanded and converted to provide two additional housing units. Figure 1 shows the site location in relation to the surrounding area.

Figure 1
Site Location Map

STUDY METHODOLOGY

This study has been prepared in three stages. The first stage involved an assessment of existing conditions within the study area and included an inventory of roadway geometrics, pedestrian and bicycle facilities and public transportation services. Existing traffic counts were performed at the study area intersections.

In the second stage of the study, future traffic conditions were projected and analyzed. Specific travel demand forecasts for the project were assessed along with future traffic demands due to expected traffic growth independent of the proposed project. In accordance with Massachusetts Department of Transportation (MassDOT) and Executive Office of Environmental Affairs (EEA) guidelines, the year 2023 was selected as the basis for modeling future transportation impacts of the proposed development to reflect a five-year planning horizon.

The third stage of the study presents and evaluates measures to address traffic issues, if any, and necessary improvements to accommodate the development.

STUDY AREA

Roadway geometry and traffic control information was collected for the following locations:

- Main Street and Fiske Road
- Main Street and existing site driveways

EXISTING CONDITIONS

Evaluation of existing conditions within the study area includes a description of roadway geometrics, traffic constraints, land uses at the intersections, and quantification of traffic volumes.

Existing Traffic Volumes

To establish base traffic conditions within the study area, manual turning movement and vehicle classification counts were obtained in May 2016. Peak-period turning movement counts were conducted during the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) periods. Daily traffic counts were conducted on Main Street for a two day period using automatic traffic recorders (ATR).

The traffic-volume data gathered as part of this study was collected during the month of May 2016. Data from the MassDOT was reviewed to determine the monthly variations of the traffic volumes. Based on the MassDOT data, May volumes are slightly higher than average month volumes.

Main Street was recorded to carry approximately 17,950 vehicles per day (vpd) north of Fiske Road. During the weekday morning peak hour, approximately 1,360 vehicles per hour (vph) were recorded, and during the weekday evening peak hour, approximately 1,474 vph were recorded.

Motor Vehicle Crash Data

Motor vehicle crash data for the study area intersections and roadways were obtained from the MassDOT for 2009 through 2013 the most recent three-year period for which data is available. The motor vehicle crash data was reviewed to determine crash trends in the study area. There have not been any crashes reported during the five year interval at the study area intersections. Based on a review of available Massachusetts Department of Transportation (MassDOT) data, the last crash at the intersection of Main Street and Fiske Road occurred in April 2007.

PROBABLE IMPACTS OF THE PROJECT

No-Build Traffic Volumes

To determine the impact of site-generated traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to the year 2023. Traffic volumes on the roadway network at that time, in the absence of the proposed project, would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific developments by others expected to be completed by 2023. A one-half (0.5) percent compounded growth rate was used to develop future No-Build baseline conditions.

Discussions with the Town of Wenham indicate that at this time there is one other potential project that has been identified that would need to be included in the No-Build projections. This is the proposed senior housing project, The Maples, located on Main Street. Potential traffic form this project was included in the background projections.

Build Traffic Volumes

Site generated traffic was based on trip-generation data published by the Institute of Transportation Engineers (ITE) in the *Trip Generation* manual[2]. The trip generation data for Land Use Code (LUC) 230 – Townhouse/Condominium, published by the ITE were evaluated to determine the expected trip generation for the project's components.

On a typical weekday, the proposed residential development is expected to generate 192 daily vehicle trips (96 vehicles entering and 96 vehicles exiting). During the weekday morning peak hour, 17vehicle trips (3vehicles entering and 14vehicles exiting) are expected. During the weekday evening peak hour, 19 vehicle trips (13 vehicles entering and 6 vehicles exiting) are expected. Most of this traffic is expected to be automobiles.

TRAFFIC OPERATIONS ANALYSIS

In order to assess the impacts of the proposed project on the roadway network, traffic operations analyses were performed at the study area intersections under 2016 Existing, 2023 No-Build and 2023 Build conditions. These analyses indicate that the proposed project will not result in a significant impact on traffic operations at the study area intersections over No-Build conditions.

The side street left-turn volume onto Main Street at the study area intersections is in each case less than 20 vehicles per hour during peak periods, with projected volume-to-capacity (v/c) ratios that will be well below 1.00. This indicates that there will be adequate capacity to accommodate the anticipated traffic volumes from the side streets,

[2]*Trip Generation*, Ninth Edition; Institute of Transportation Engineers; Main, DC; 2012.

as well as from Pine Hill Drive onto Main Street. While the capacity analyses indicate that the critical movements at the Main Street and Pine Hill Drive intersection are projected to operate at LOS D during the weekday morning peak hour and at LOS E during the weekday evening peak hour, this is caused primarily due to the existing volume of traffic on Main Street during the peak hours.

RECOMMENDATIONS

The capacity analyses performed for the unsignalized study area intersections indicate that overall, the intersections operate at good levels of service, with minor delays for the critical movements.

The Pine Hill Drive should consist of one lane in and one lane out, with the exiting lane under STOP sign control. Vegetation or proposed landscaping along both Main Street in front of the site and within the layout should be cleared and maintained so as to maintain sight distances.

SUMMARY

Review of the proposed project and access plan shows that in relation to roadway capacity, traffic safety, and traffic impacts upon the surrounding roadway network, the proposed residential development will have minimal impact on the surrounding roadways and intersections. The existing roadway system has sufficient capacity for the proposed project.

SECTION 2: EXISTING TRAFFIC CONDITIONS

STUDY AREA

Roadway geometry and traffic control information was collected for the following locations:

- Main Street and Fiske Road
- Main Street and existing site driveways

FIELD SURVEY

A comprehensive field inventory of the proposed site was conducted in May 2016. The inventory included collection of existing roadway geometrics, traffic volumes, and safety data for the existing study area intersections and site access driveway locations. Traffic volumes were measured by means of automatic traffic recorder (ATR) counts and substantiated by manual turning movement counts (TMCs) conducted at the study area intersections.

GEOMETRICS

Primary study area roadways are described below.

Roadways

Main Street (Route 1A)

Main Street is a two-lane, Urban Principal Arterial under the jurisdiction of the MassDOT. Main Street traverses the study area in a general north/south direction. Additional turn lanes are provided at major intersections. Travel lanes are generally separated by a double yellow centerline. Marked shoulders are also provided. The posted speed limit on Main Street in the vicinity of the site is 35 miles per hour (mph). A sidewalk is provided along the east side of the road. Land use along Main Street in the

study area consists of primarily residential homes and the existing golf course.

Intersections

Main Street and Fiske Road

Main Street forms the north and south legs of this three legged unsignalized intersection with Fiske Road (west leg). The Main Street northbound approach consists of single lane permitting left-turns. The Main Street southbound approach consists of a single lane permitting right-turns. The Fiske Road approach consists of a single lane permitting left- and right-turns. Fiske Road is under STOP-sign control. There is a sidewalk along the east side of Main Street. Land use at the intersection consists of residential homes and the existing golf course.

Main Street and North Site Driveway

Main Street forms the north and south legs of this three legged unsignalized intersection with the north site driveway (east leg). The Main Street northbound approach consists of single lane permitting right-turns. The Main Street southbound approach consists of a single lane permitting left-turns. The driveway approach consists of a single lane permitting left- and right-turns. The driveway operates under STOP-like control. There is a sidewalk along the east side of Main Street. Land use at the intersection consists of residential homes and the existing golf course.

Main Street and South Site Driveway

Main Street forms the north and south legs of this three legged unsignalized intersection with the south site driveway (east leg). The Main Street northbound approach consists of single lane permitting right-turns. The Main Street southbound approach consists of a single lane permitting left-turns. The driveway approach consists of a single lane permitting left- and right-turns. The driveway operates under STOP-like control. There is a sidewalk along the east side of Main Street. Land use at the intersection consists of residential homes and the existing golf course.

TRAFFIC VOLUMES

Existing Traffic Volumes

To establish base traffic conditions within the study area, manual turning movement and vehicle classification counts were obtained in May 2016. Peak-period turning movement counts were conducted during the weekday morning peak period (7:00 to 9:00 AM) and weekday evening period (4:00 to 6:00 PM) at the following intersections:

- Main Street and Fiske Road
- Main Street and existing site driveways

Daily traffic counts were conducted on Main Street for a two day period using automatic traffic recorders (ATR). The ATR counts were obtained in May 2016.

Analysis of the peak-period traffic counts indicated that the weekday morning commuter peak generally hour occurs between 7:30 and 8:30 AM and the weekday evening commuter peak hour generally occurs between 5:00 and 6:00 PM. The traffic count worksheets are provided in the Appendix.

Seasonal Adjustment

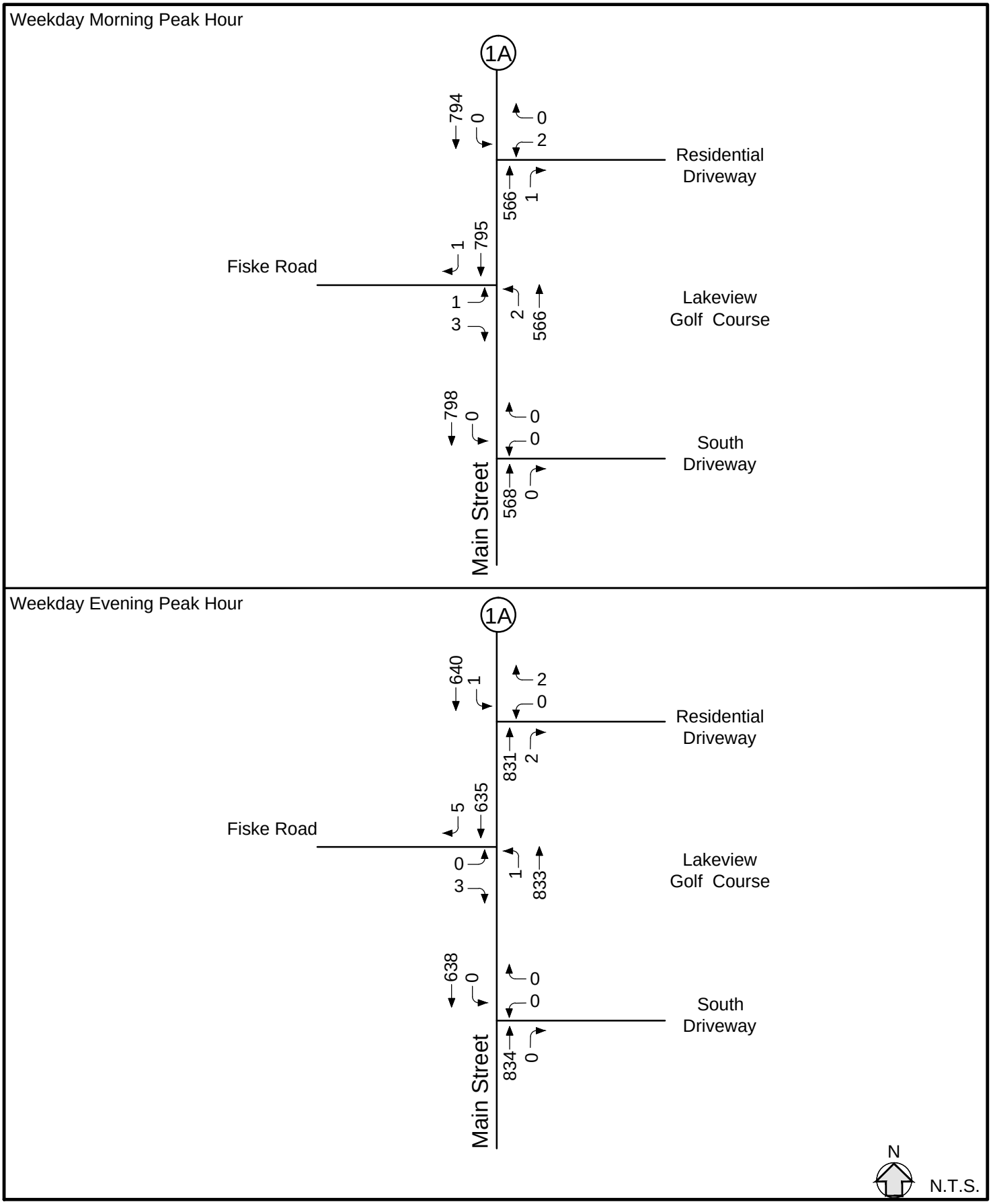
The manual turning movement traffic-volume data gathered as part of this study was collected during the month of May 2016. Data from the MassDOT was reviewed to determine the monthly variations of the traffic volumes. The traffic data showed May volumes to be slightly higher than average month conditions. Therefore, the May traffic volumes were used in order to provide for a conservative analysis scenario. The 2016 existing daily and peak-hour traffic volumes for average-month conditions are summarized below in Table 1. The 2016 Existing peak hour traffic flow networks are shown graphically on Figure 2 for the weekday morning and evening peak hours. The seasonal worksheets are provided in the Appendix.

TABLE 1
EXISTING WEEKDAY TRAFFIC-VOLUME SUMMARY[a]

Location	Weekday Traffic Volume[b]	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		Traffic Volume[c]	K Factor[d]	Directional Distribution[e]	Traffic Volume	K Factor	Directional Distribution
Main Street, north of Fiske Road	17,950	1,360	7.6	56.4% SB	1,474	8.2	56.5% NB

[a]Two-way traffic volume
[b]Daily traffic expressed in vehicles per day.
[c]Expressed in vehicles per hour.
[d]Percent of daily traffic volumes which occurs during the peak hour.
[e]Percent of peak-hour volume in the predominant direction of travel.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.

Main Street was recorded to carry approximately 17,950 vehicles per day (vpd) north of Fiske Road. During the weekday morning peak hour, approximately 1,360 vehicles per hour (vph) were recorded, and during the weekday evening peak hour, approximately 1,474 vph were recorded.



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BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Wenham Pines
Wenham, MA

Figure 2

2016 Existing
Peak Hour Traffic Volumes

VEHICLE SPEEDS

Existing speed data for Main Street was also collected using the ATR. The posted speed limit on Main Street is 35 mph. The speed data is summarized in Table 2.

As shown in Table 2, the average speed of vehicles travelling northbound or southbound on South Street was found to be 36 to 35 mph. The 85th percentile speed was found to be 40 mph for northbound vehicles and 39 mph for southbound vehicles. The average speed of vehicles travelling eastbound or westbound on Fuller Street was found to be 33 to 32 mph, respectively. The 85th percentile speed was found to be 39 mph for eastbound vehicles and 38 mph for westbound vehicles The 85th percentile speed is the speed at which sight distances are typically evaluated.

TABLE 2
OBSERVED VEHICLE SPEEDS

Direction	Posted Speed Limit (mph)	Average Observed Speed[a] (mph)	85th Percentile Speed (mph)
Main Street Northbound	35	32	34
Main Street Southbound	35	34	37

[a]Based on speed data compiled on May 3 through May 5, 2016.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash data for the study area intersections and roadways were obtained from the MassDOT database for 2009 through 2013, the most recent five-year period for which data is available. The motor vehicle crash data was reviewed to determine crash trends in the study area. There have not been any crashes reported during the five year interval at the study area intersections. Based on a review of available Massachusetts Department of Transportation (MassDOT) data, the last crash at the intersection of Main Street and Fiske Road occurred in April 2007. No crashes were reported at the site driveways.

PUBLIC TRANSPORTATION

There is currently no public transportation service to Main Street in Wenham provided by the MBTA.

PLANNED ROADWAY IMPROVEMENTS

Officials for MassDOT and the Town of Wenham were contacted regarding roadway improvements planned for the study area intersections. No improvements are currently planned.

SECTION 3:
2023 NO-BUILD AND BUILD TRAFFIC CONDITIONS

To determine the impact of site-generated traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to the year 2023. Traffic volumes on the roadway network at that time, in the absence of the proposed project, would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific developments by others expected to be completed by 2023. Consideration of these factors resulted in the development of 2023 No-Build traffic volumes. Anticipated site-generated traffic volumes were then superimposed upon these No-Build traffic flow networks to develop 2023 Build conditions.

2023 NO-BUILD TRAFFIC VOLUMES

Traffic growth on area roadways is a function of the expected land development in the immediate area as well as the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may actually grow at either a higher or a lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This produces a more realistic estimate of growth for local traffic. However, the drawback of this procedure is that the potential growth in population and development external to the study area would not be accounted for in the traffic projections.

To provide a conservative analysis framework, both procedures were used.

Background Traffic Growth

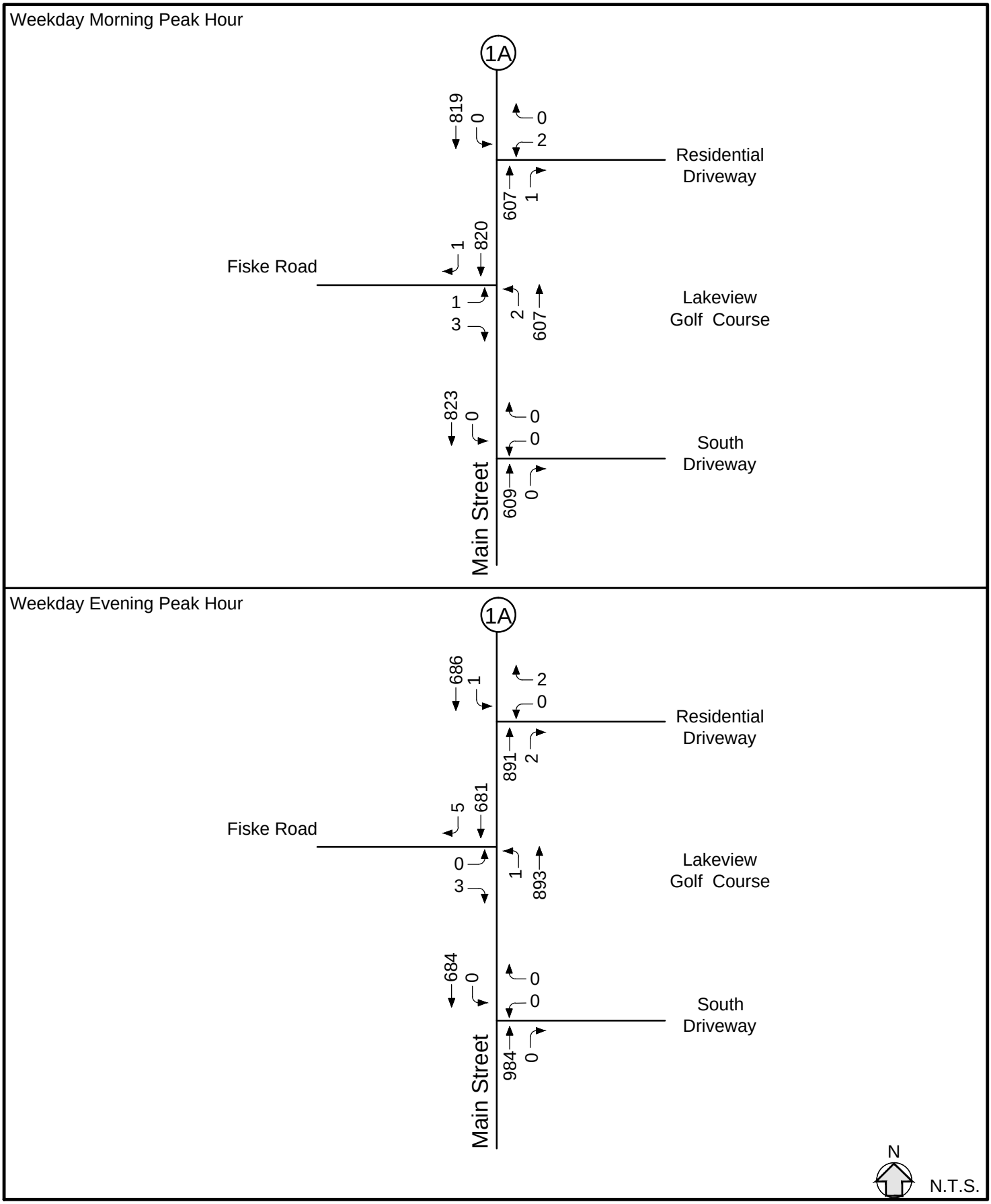
The Metropolitan Area Planning Council (MAPC) was contacted to determine regional growth for Wenham and the surrounding area. Based on this data, growth is expected to occur at a rate of 0.30 percent per year. To provide a conservative analysis, a background growth rate of 1.0 percent per year was applied.

Specific Development by Others

Traffic volumes generated by the specific local developments by others were included in the 2023 No-Build condition. The Town of Wenham was contacted to identify specific planned developments. Based on these discussions, there are no project's that are currently planned, approved or under construction in the immediate area that would impact future traffic volumes beyond the general background traffic growth rate.

No-Build Condition Traffic Volumes

The 2023 No-Build weekday morning peak-hour traffic volumes were developed by applying a compounded one percent annual growth rate to the 2016 Existing peak-hour through movement traffic volumes. Figure 3 shows the projected 2023 No-Build peak hour traffic volumes for the weekday morning and weekday evening peak-hour conditions.



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BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

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Wenham, MA

Figure 3

2023 No-Build
Peak Hour Traffic Volumes

FUTURE 2023 BUILD CONDITIONS

Project Description

Wenham Pines is to consist of twenty-five (25) condominium units in eleven free standing buildings. The existing north site driveway is proposed to be closed. A new driveway, to be known as Pine Hill Road will be constructed opposite Fiske Road to serve the new condominium units. The existing south site driveway will be maintained and will continue to serve the existing home that is located on the site that will be expanded and converted to provide two additional housing units.

Site Traffic Generation

Site generated traffic was based on trip-generation data published by the ITE *Trip Generation* manual[3]. The trip generation data for Land Use Code (LUC) 230 – Townhouse/Condominium published by the ITE was evaluated to determine the expected trip generation for the proposed project. The expected trip generation is summarized in Table 3 and the trip generation worksheets are included in the Appendix.

TABLE 3
RESIDENTIAL DEVELOPMENT
TRIP-GENERATION SUMMARY

	Proposed Residential Trips[a]
Average Weekday Daily Traffic	192
Weekday Morning Peak Hour:	
Entering	3
Exiting	14
Total	17
Weekday Evening Peak Hour:	
Entering	13
Exiting	6
Total	19

[a]Based on LUC 230 – Townhouse/Condominium, 25 dwelling units.

On a typical weekday, the proposed residential development is expected to generate 192 daily vehicle trips (96 vehicles entering and 96 vehicles exiting). During the weekday

[3]*Trip Generation*, Ninth Edition; Institute of Transportation Engineers; Main, DC; 2012.

morning peak hour, 17vehicle trips (3vehicles entering and 14vehicles exiting) are expected. During the weekday evening peak hour, 19 vehicle trips (13 vehicles entering and 6 vehicles exiting) are expected. Most of this traffic is expected to be automobiles.

Trip Distribution

The directional distribution of the vehicular traffic approaching and departing the site is a function of population densities, the location of employment, existing travel patterns, similar uses, and the efficiency of the existing roadway system. Table 4 summarizes the expected trip distribution for the residential project.

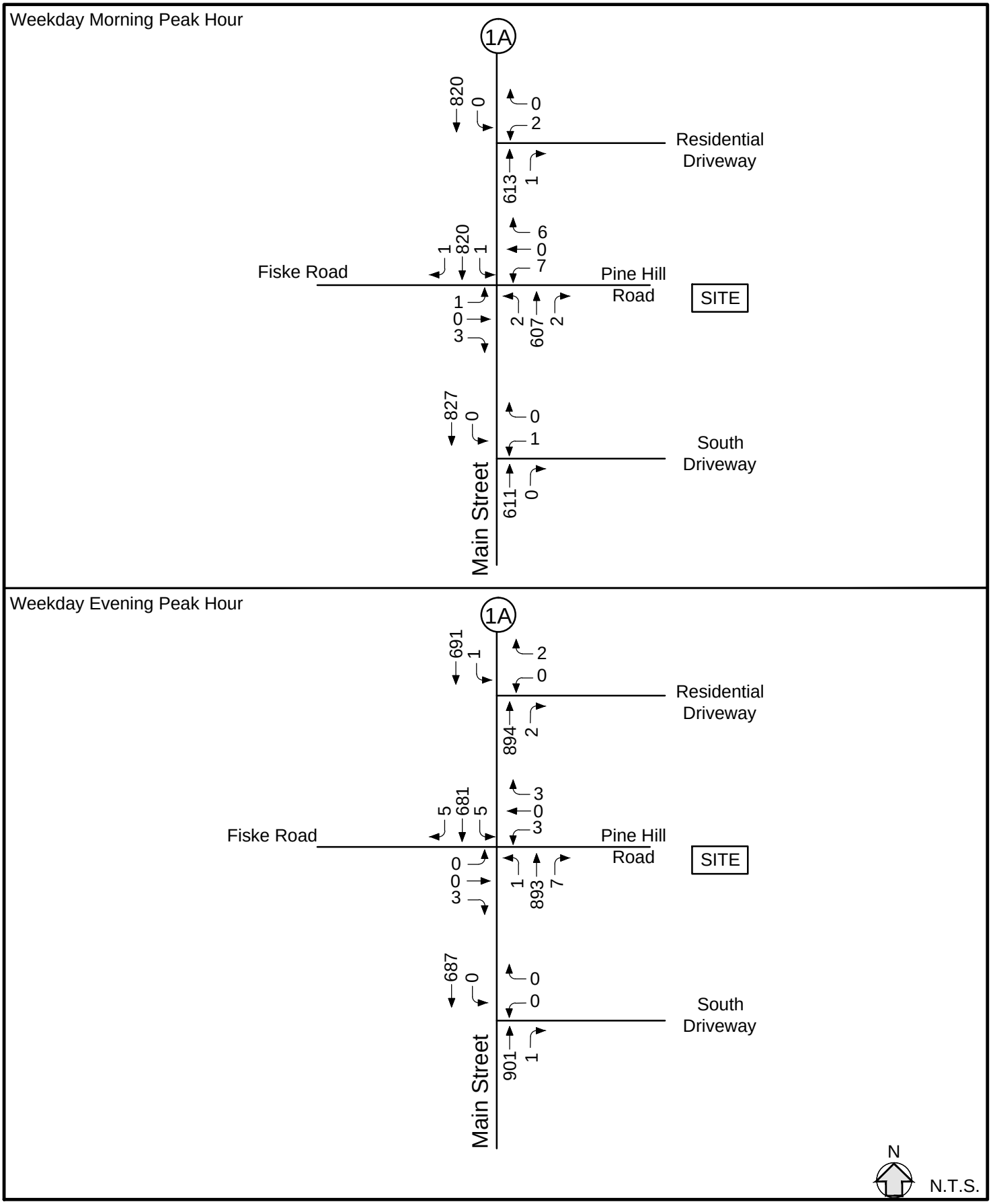
TABLE 4
PROPOSED TRIP DISTRIBUTION

Route	Direction	Percent of Residential Development Trips
Main Street	North	43
Main Street	South	57
TOTAL		100

Future Traffic Volumes - Build Condition

The site-generated traffic was distributed within the study area according to the percentages summarized in Table 4. The site generated volumes were superimposed onto the 2023 No-Build traffic volumes to represent the 2023 Build traffic-volume conditions. The anticipated 2023 Build weekday morning and weekday evening traffic volumes are graphically presented in Figure 4. These volumes were used as the basis for all analysis as well as to identify potential mitigation measures to ameliorate the project's impacts.

A summary of 2023 peak-hour projected traffic-volume changes in the site vicinity are shown in Table 5. These volumes are based on the expected increases from the site traffic generation.



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BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Wenham Pines
Wenham, MA

Figure 4

2023 Build
Peak Hour Traffic Volumes

TABLE 5
TRAFFIC-VOLUME INCREASES[a]

Location/Peak Hour	2023 No-Build	2023 Build	Volume Increase over No-Build	Percent Increase over No-Build
Main Street, north of Site				
Weekday Morning	1,426	1,433	7	0.5
Weekday Evening	1,580	1,588	8	0.5
Main Street, south of Site				
Weekday Morning	1,432	1,448	16	1.1
Weekday Evening	1,578	1,589	11	0.7

[a]All volumes are vehicles per hour, total of both directions.

As shown in Table 5, project-related increases are in the range of 7 to 16 bi-directional vehicles during the peak hours. This is approximately equivalent to one additional vehicle every 8 minutes or less per direction on average during the peak hours.

SECTION 4: CAPACITY ANALYSIS

To assess intersection operations, capacity analyses were conducted for Existing, No-Build, and Build traffic-volume conditions. Capacity analyses provide an indication of how well the study area intersections serve existing and projected traffic volumes. Vehicle queue analyses provide a secondary measure of the operational characteristics of an intersection or section of roadway under study in terms of lane use and demand.

METHODOLOGY

Levels of Service

Level of service (LOS) is a quantitative measure used to describe the operation of an intersection or roadway segment. The level of service definition is described by the quality of traffic flow and is primarily defined in terms of traffic delays. The primary result of capacity analyses[4] is the assignment of a level of service to traffic intersections or roadway segments under various traffic-flow conditions. Six levels of service are defined for traffic intersections and roadway segments. Levels of service range from LOS A to LOS F. LOS A represents very good operating conditions and LOS F represents very poor operating conditions.

Unsignalized Intersections

The level of service for an unsignalized intersection is determined by the methodology and procedures described in the 2010 *Highway Capacity Manual.*[5] The level of service for unsignalized intersections is measured in terms of average delay for the critical movements (typically side street turning movements or mainline turning movements). The delay for the critical movements is a function of the available capacity for the movement and the degree of saturation of the lane group containing the critical

[4]The capacity analysis methodology is based on procedures presented in the *Highway Capacity Manual;* Transportation Research Board; Main, DC; 2010.

[5]*Highway Capacity Manual*; Transportation Research Board; Main, DC; 2010.

movement. The delay calculation includes the effects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. The definitions for level of service at unsignalized intersections are also provided in the 2010 *Highway Capacity Manual*. Table 6 summarizes the relationship between level of service and average control delay for the critical movements at unsignalized intersections.

TABLE 6
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Average Delay (seconds per vehicle)	Resulting Level of Service
≤ 10.0	A
10.1 to 15.0	B
15.1 to 25.0	C
25.1 to 35.0	D
35.1 to 50.0	E
>50.0	F

[a]*Highway Capacity Manual*; Transportation Research Board; Main, DC; 2010; page 17-2.

The analytical methodologies used for the analysis of unsignalized intersections use conservative analysis parameters, such as high critical gaps. The critical gap is defined as the minimum time between successive main line vehicles for a side street vehicle to execute the appropriate turning maneuver. Actual field observations indicate that drivers on minor streets accept smaller gaps in traffic than those used in the analysis procedures and therefore experience less delay than calculated by the HCM methodology. ***The analysis results overstate the actual delays experienced in the field.*** It should be noted that the unsignalized intersections along heavily trafficked roadways operate at constrained levels and the resulting calculated results of the unsignalized intersection analyses should be considered highly conservative.

Signalized Intersections

Levels of service for signalized intersections are calculated using the methodology and procedures described in the 2010 *Highway Capacity Manual*. The methodology assesses the intersection based on type of signal operation, signal timing and phasing, progression, vehicle mix, and intersection geometrics. Level-of-service designations are based on the delay per vehicle. Table 7 summarizes the relationship between level of service and delay. The calculated delay values result in level-of-service designations which are applied to individual lane groups, to individual intersection approaches, and to the entire intersection.

TABLE 7
LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS[a]

Delay per Vehicle (Seconds)	Resulting Level of Service
≤10.0	A
10.1 to 20.0	B
20.1 to 35.0	C
35.1 to 55.0	D
55.1 to 80.0	E
>80.0	F

[a]*Highway Capacity Manual*; Transportation Research Board; Main, DC; 2010; page 16-2.

ANALYSIS RESULTS

Level-of-service analyses were conducted for 2016 Existing, 2023 No-Build, 2023 Build conditions for the intersections within the study area. The results of the unsignalized analyses are in Table 8. Actual field observations indicate that drivers on minor streets did not experience the delays that the HCM methodology indicates, further supporting the conservative nature of the analysis methodology. Again, it is important to note that the analysis results overstate the actual delays experienced in the field**.** Detailed analysis sheets are presented in the Appendix.

Main Street and Fiske Road

Under 2016 Existing weekday morning conditions, this signalized intersection is modeled to operate at LOS B during the weekday morning peak hour and at LOS B during the weekday evening peak hour. Under future 2023 No-Build conditions, this intersection is projected to operate at LOS B during the weekday morning peak hour and at LOS C during the weekday evening peak hour. Under 2023 Build conditions, with the project, the intersection is projected to continue to operate at LOS C during the weekday morning peak hour and at LOS C during the weekday evening peak hour.

TABLE 8
UNSIGNALIZED LEVEL-OF-SERVICE ANALYSIS SUMMARY

Critical Movement/ Peak Hour	2016 Baseline				2023 No-Build				2023 Build			
	Demand[a]	V/C[b]	Delay[c]	LOS[d]	Demand	V/C	Delay	LOS	Demand	V/C	Delay	LOS
Main Street and Existing North Driveway												
All movements from driveway:												
Weekday Morning	2	0.02	32.3	D	2	0.02	35.3	E	2	0.02	35.6	E
Weekday Evening	2	0.01	15.4	C	2	0.01	16.3	C	2	0.01	16.3	C
Main Street and Fiske Road												
All movements from Fiske Road:												
Weekday Morning	4	0.02	20.0	C	4	0.02	20.9	C	4	0.02	24.1	C
Weekday Evening	3	0.02	13.3	B	3	0.02	13.9	B	3	0.02	13.9	B
All movements from Pine Hill Road:												
Weekday Morning												
Weekday Evening	--	--	--	--	--	--	--	--	13	0.10	33.8	D
	--	--	--	--	--	--	--	--	6	0.06	38.2	E
Main Street and Existing South Driveway												
All movements from driveway:												
Weekday Morning	0	0.00	0.0	A	0	0.00	0.0	A	1	0.01	31.7	D
Weekday Evening	0	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A

[a]Demand of critical movements in vehicles per hour.
[b]Volume-to-capacity ratio.
[c]Delay in seconds per vehicle.
[d]Level of service.

Main Street and Existing North Driveway

Under 2016 Existing conditions, during the weekday morning peak hour, the critical movements (all movements from the driveway) are projected to operate at LOS D and at LOS C during the weekday evening peak hour. Under future 2023 No-Build conditions, these critical movements are projected to operate at LOS E during the weekday morning peak hour and at LOS C during the weekday evening peak hour. Under future 2023 Build conditions, with the project, these critical movements are projected to continue to operate at LOS E during the weekday morning peak hour and at LOS C during the weekday evening peak hour. The driveway volume is less than 10 vehicles per hour during peak periods with volume-to-capacity (v/c) ratio that will be well below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes. The additional traffic generated by the proposed project is not anticipated to increase queues within this lane.

Main Street and Fiske Road

Under 2016 Existing conditions, during the weekday morning peak hour, the critical movements (all movements from Fiske Road) are projected to operate at LOS C and at LOS B during the weekday evening peak hour. Under future 2023 No-Build and Build conditions, these critical movements are projected to operate at LOS C during the

weekday morning peak hour and at LOS B during the weekday evening peak hour. Under future 2023 Build conditions, with the project, the critical movements from Pine Hill Road are projected to continue to operate at LOS D during the weekday morning peak hour and at LOS E during the weekday evening peak hour. The side street left-turn volume is less than 20 vehicles per hour during peak periods, with a projected volume-to-capacity (v/c) ratio that will be well below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes.

Main Street and Existing South Driveway

Under 2016 Existing conditions, during the weekday morning and weekday evening peak hours, the critical movements (all movements from the driveway) are projected to operate at LOS A. Under future 2023 No-Build conditions, these critical movements are projected to continue to operate at LOS A during the weekday morning and weekday evening peak hours. Under future 2023 Build conditions, with the project, these critical movements are projected to continue to operate at LOS D during the weekday morning peak hour and at LOS A during the weekday evening peak hour.

SIGHT DISTANCE

Sight distance measurements were performed at the intersection of Pine Hill Road with Main Street in accordance with Massachusetts Department of Transportation (MassDOT) and American Association of State Highway and Transportation Officials (AASHTO) standards. Stopping sight distance (SSD) measurements were performed. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an object in its travel path. Intersection sight distance (ISD) or corner sight distance (CSD) is the sight distance required by a driver entering or crossing an intersecting roadway, to perceive an on-coming vehicle and safely complete a turning or crossing maneuver with on-coming traffic. Table 9 presents the measured SSD at the intersection of Pine Hill Road at Main Street. The sight distance calculations are included in the Appendix.

As can be seen in Table 9, the SSD measurements performed at Pine Hill Road intersection with Main Street indicate that the intersection exceeds the recommended minimum requirements based on the 85th percentile speeds. In accordance with the AASHTO manual, *"If the available sight distance for an entering or crossing vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to anticipate and avoid collisions. However, in some cases, this may require a major-road vehicle to stop or slow to accommodate the maneuver by a minor-road vehicle. To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road."* Accordingly, the ISD should be at least equal to the SSD, which would allow a driver approaching the minor road to safely stop. It is recommended that any proposed landscaping be less than three (3) feet in height and maintained for sight lines.

TABLE 9
SIGHT DISTANCE SUMMARY

	Required Minimum (Feet)[a]	Measured (Feet)
Main Street and Pine Hill Road		
Stopping Sight Distance:		
Main Street approaching from the north	267	485
Main Street approaching from the south	236	400
Intersection Sight Distance:		
Main Street looking to the north	354[b]/408[c]	485
Main Street looking to the south	354[b]/408[c]	315

[a]Recommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets*; American Association of State Highway and Transportation Officials (AASHTO); 2010, and based on 85th percentile speed for Main Street.
[b]Recommended minimum value for vehicles turning right exiting a roadway under STOP-sign control.
[c]Recommended minimum value for vehicles turning left exiting a roadway under STOP-sign control.

SECTION 5: RECOMMENDATIONS AND CONCLUSION

RECOMMENDATIONS

The final phase of the analysis process is to identify the mitigation measures necessary to minimize the impact of the project on the transportation system. The proponent has made a commitment to implement the mitigation measures listed below.

The capacity analyses performed for the unsignalized study area intersections indicate that overall, the intersections operate at good levels of service, with minor delays for the critical movements.

The side street left-turn volume onto Main Street at the study area intersections is in each case less than 20 vehicles per hour during peak periods, with projected volume-to-capacity (v/c) ratios that will be well below 1.00. This indicates that there will be adequate capacity to accommodate the anticipated traffic volumes from the side streets, as well as from Pine Hill Drive onto Main Street. While the capacity analyses indicate that the critical movements at the Main Street and Pine Hill Drive intersection are projected to operate at LOS D during the weekday morning peak hour and at LOS E during the weekday evening peak hour, this is caused primarily due to the existing volume of traffic on Main Street during the peak hours.

Vegetation or proposed landscaping along both Main Street in front of the site and within the layout should be cleared and maintained so as to maintain sight distances.

CONCLUSION

The residential development is located on the east side of Main Street, opposite Fiske Road. On a typical weekday, the residential development is expected to generate approximately 192 vehicle trips. During the weekday morning peak hour, 17 vehicle trips (3 vehicles entering and 14 vehicles exiting) are expected. During the weekday evening peak hour, 19 vehicle trips (13 vehicles entering and 6 vehicles exiting) are expected. Most of this traffic is expected to be automobiles.

Capacity analyses were performed for each of the study area intersections for 2016 Existing, 2023 No-Build and 2023 Build conditions. Based on the analyses performed, there is no significant change in level of service from No-Build to Build conditions at the signalized study area intersections.

It is recommended that Pine Hill Drive should consist of one lane in and one lane out, with the exiting lane under STOP sign control. Vegetation or proposed landscaping along Main Street in front of the site and within the layout should be cleared and maintained so as to maintain sight distances.

Review of the proposed residential development and access plan shows that in relation to roadway capacity, traffic safety, and traffic impacts upon the surrounding roadway network, the proposed project will meet safety standards and have a minimal impact on existing traffic conditions. With the proposed access, in conjunction with the mitigation measures described above and maintaining sight distances from the driveway (clear sight lines along frontage), safe and efficient access can be provided to the clienteles of the proposed residential development and to the motoring public in the area.